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BY

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EXPLOSIONS AND OTHER ACCIDENTS FROM MUDCAPPED SHOTS IN COAL MINES [1]

By D. Harrington[2] and C. W. Owings[3]

Each year at least one and in some years several explosions are reported as having resulted from firing of mudcapped shots in coal mines; undoubtedly a number of small or local explosions occur that are not reported; in addition there are numerous accidents, some of them fatal, attributable to this reprehensible blasting practice. It is surprising that so few explosions and other accidents from this cause occur since the practice of firing mudcapped, "adobe," "dobe," "sand blast," or "bulldozed" shots is widespread. Even in gassy mines where general blasting is safeguarded by being done with permissible explosives, rocks or bowlders frequently are blasted with mudcapped shots of dynamite; even if permissible explosives are used, this type of shooting is dangerous.

The usual method of preparing a mudcapped shot is to place the explosive, either in loose or cartridge form, with the detonator or "cap" on top of a piece of rock or coal and cover it with several handfuls of moist clay, loam, sand, or road dust; in many cases there is no covering of any kind. When the shot is fired a dense cloud of dust, together with an intensively hot flame, are thrown into suspension, and if the dust is explosive or ignitable an explosion or ignition is likely to result practically simultaneously. The presence of gas greatly increases the explosibility of the dust, as well as the probability of an ignition. Every shot, of any known explosive, fired in a coal mine without having the charge properly confined in a drill hole and tamped with incombustible stemming to the collar of the hole, is capable of initiating an explosion that may cause the death of every man in the mine.

Attention has recently been directed to this unsafe practice by an explosion resulting from a flagrant disregard of safe blasting practices in one of our most productive coal-mining regions. The mine had been idle for several years and was being prepared for reopening on a different system of mining. Six to 10 inches of bottom coal had been left in place during former mining operations, but in the new system it was felt desirable to remove the bottom coal left in certain parts of the mine. Instead of drilling holes in the coal, loading them, and firing in the usual safe manner, five or six charges of dynamite were placed on top of the coal in each of several rooms; and while the men were at the mouth of the

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rooms during the lunch hour, shot firers started blasting. Shortly after the blasts in the first room had been fired an explosion occurred, seriously burning one man and slightly burning several others. The explosion is directly attributable to firing mudcapped shots, and it is improbable that any explosive gas was present. It is possible that the dust raised by the first round of blasts was carried by the ventilating current into the room where the second blasts were fired, or some of the charges detonated before the others, raising a cloud of dust, and that the flame from the high explosive ignited the dust. The explosion was local in extent, traveling about 150 to 200 feet, nevertheless several persons were injured. Open lights were used, as the mine was classified as nongassy. In such mines the dangerous, explosive qualities of the coal-dust are generally disregarded and perhaps for that reason mudcapping is even more hazardous than in mines recognized as gassy, because in "gassy" mines it is almost inconceivable that this type of blasting would be tolerated.

About a year previous to the above explosion, a similar explosion occurred in another mine of the same company, resulting in the death of eight men, one of whom died from breathing afterdamp during recovery work; more than 50 men escaped unassisted immediately following the explosion and several others escaped about eight hours later when ventilation had been partly restored. In this mine permissible explosives, detonators, and fuse were used to blast coal, and 40 per cent strength dynamite was used for blasting rock. On the evening of the explosion two employees were issued 36 cartridges of dynamite for use in blasting a fall of slate; eight of these cartridges were found after the explosion, indicating that 28 cartridges were used to blast the slate. Evidence indicates that two shots were placed about 10 feet apart on the slate fall and the fuse on each charge lighted. Evidently one charge detorated first, throwing a dense cloud of dust into the air, and this dust was ignited by the second shot, the firing of which occurred almost immediately after the first one had acted. Coal-dust was ignited and coal-dust propagated the explosion, which was violent and covered a considerable area. Several doors, an overcast, more than 50 stoppings, and many timbers were blown out. During the recovery work three men attempted to enter the motor barn without any protection. One man was overcome and later died. Open lights were used in this mine also. The lesson to be learned from this, as well as in the previous instance, is that coal-dust is dangerous even in nongassy mines, and if the dust is raised into a cloud in the presence of a flame resulting from explosive fired in a mudcapped shot, it may ignite and explode. In this mine the dangerous condition of the dust had been recognized by the State mine inspector, who called attention to the hazard in his report on the mine, made previous to the explosion.

A coal-dust explosion occurred in another open-light mine when a mudcapped charge of 10 cartridges of 60 per cent strength dynamite, placed on top of a piece of sandstone, was fired. The coal-dust was of a naturally explosive character and had combustible content of 80 to 93 per cent. The company rules forbade firing mudcapped shots; hence those who fired the shots were definitely responsible for the result. Both permissible explosive and straight dynamite were allowed in the mine at the same time, hence the company was also at fault and should shoulder its share of the blame. Six men lost their lives in this explosion.

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Six men also lost their lives in an explosion in a coal mine where practices and conditions were generally of a safe nature. The explosion resulted from the firing of two mudcapped charges of 40 per cent gelatin dynamite which were used to break a fall of sandstone. The cloud of dust raised by the detonation of the explosive was ignited by the accompanying flame and resulted in an explosion which, although local in extent, probably would have been widespread if the entries had not been well rock-dusted. The mine observed many safety practices and the management recognized that the mine was gassy, requiring all underground employees to wear approved electric cap lamps and to use permissible explosives for blasting down the coal; it has been found that in very many cases mines having an unusually large percentage of safe practices and conditions use mudcapped shots with dynamite as the explosive.

In these four comparatively recent explosions from mudcapped shots, (and numerous others could be instanced as having occurred during the past 13 years) 20 men lost their lives and 10 men were injured; three of the injured owed their lives to prompt rescue by fellow workers and to the effective application of artificial respiration. The lives of more than 360 men were endangered, hence the potential death list was nearly 400. The record is the more disgraceful when it is considered that the injuries and fatalities were the direct result of gross carelessness.

Mudcapping is wasteful of explosive and time as well as of life and limb. At least 90 per cent of the force of the explosive is expended on the air, hence much of the explosive is wasted. The proper method of blasting bowlders or large pieces of rock, thin layers of coal, or lumps of coal too large to handle, is to drill holes, place the explosive in them, tamp the charge well with incombustible stemming, and then fire the shots electrically. It takes only a very few minutes to drill a hole even in hard sandstone, and in the case of a roof fall, small pieces may be loaded while the hole is being drilled, hence little or no time is lost. The efficient effect of the blast so prepared and fired is much greater than a mudcapped shot.

The fact that the rock is not usually well broken by mudcapped shots is recognized in some mines. In a Pennsylvania mine recently a man lost his life in a delayed explosion of a mudcapped shot. He had carefully "grooved" the rock in a roof fall, and placed a mudcapped charge in the groove. When the shot hung fire he returned to investigate and was killed as the charge exploded. Investigation showed that it was common practice to "groove" pieces of rock to be blasted with mudcapped shots. Explosive and time would have been saved if a hole had been drilled in the rock, and probably the miner's life would have been spared. In numerous instances where explosions have not occurred from mudcapping shots, those in the vicinity have been injured from flying particles.

In most of the explosions from mudcapped shots, coal-dust was ignited and coal-dust propagated the explosion. Another important fact is that where two or more shots are fired, the liability that an explosion will result is greater than when single shots are fired. Undoubtedly in most cases one of the shots,

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especially where ordinary fuse is used, acts before the other or others; a relatively dense cloud of combustible dust is raised and the temperature of the air is raised by the heat liberated from the unconfined explosive; the second shot or succeeding shots, may stir up more dust, increase the temperature of the air, and ignite the dust-air mixture. Thus it is seen that mudcapped shots bring about conditions that fulfill the threefold requirement for a coal-dust explosion; (1) there must be combustible dust present, (2) the dust must be raised into a dense cloud, and (3) there must be a source of flame at the time and at the place where the dust is raised into a cloud. Many coal-mining people seem to think that when shooting a rock fall in a coal mine or shooting rock roof over coal or rock floor under coal, there is no hazard from coal-dust; this is a fallacy and it will be well for coal-mining men to feel thoroughly assured that there is a dust hazard in almost all places and under almost all circumstances in any bituminous coal mine.

Another variety of mudcapped shot is that which involves the practice of tying several cartridges of explosive to a post or prop in pillar workings and firing the charge with intent to cause a pillar fall. This is the practice in a number of so-called modern mines and is one likely to result ultimately in fires or explosions or both. If posts must be shot out, a hole should be drilled in the post; generally only a part of a stick of permissible explosive need be used, and the shooting should be done by suitable electric battery. If the roof material is to be shot, suitable holes should be drilled in the roof and the explosive charged and stemmed fully as carefully as if coal were being shot. In one mine when the roof fails to fall key posts in pillar workings are blasted in the careless manner described. The mine is gassy, as considerable methane is liberated from the coal, at times from the roof strata, and gas is given off in varying quantities in pillar workings; the return from one section has shown as much as one half of one per cent methane. Yet posts are blasted in pillar sections by tying loose cartridges of explosive to the posts! Under such conditions the danger is increased by the presence of gas and by the almost inevitable accumulation of considerable combustible dust found in practically all pillaring work.

Generally dynamite is used when firing mudcapped shots, but permissible explosives are also used; even where permissible explosive is used there is a definite explosion hazard, for the permissible explosives are not used under the prescribed conditions of safety. A permissible explosive must not be fired in excess of 1½ pounds (average of about four to six cartridges) per shot; it must be properly confined in a hole; it must be tamped with incombustible stemming; and it must not be fired in the presence of a dangerous percentage of firedamp. If any of the above conditiions are not complied with, the explosive loses its permissibility. Hence it is not safe to fire mudcapped shots even though permissible explosive is used; both gas and dust have been ignited where permissible explosives have been misused in this manner.

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It is deplorable, in view of the fact that for more than 25 years the mining industry has recognized that explosives are capable of igniting coal-dust and gas, that mudcapped shots are used so generally for blasting in the coal mines of the United States. This useless, futile, and at all times dangerous practice is found in all classes of mines - in the small wagon mine, where black blasting powder is still in evidence; in the larger mines in the so-called non-gassy coal fields, where black blasting powder or permissible explosives are utilized; and even in gassy mines where conditions are felt to be so dangerous that permissible explosives, closed lights, and permissible electrical equipment must be used. Is it due to ignorance? Is it only thoughtlessness? Or is it carelessness? In any event it is UNNECESSARY, UNECONOMICAL, and UNSAFE. Unnecessary accidents of this kind can be prevented by using only permissible explosives, properly confined, with incombustible stemming in drill holes. In the name of safety, mudcapped shots should never be fired in any coal mine whether gassy or nongassy.

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